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by William P. Monan

- "My First Officer was flying. A military transport had landed on Runway 24[R], [and] was instructed to turn left and hold short of 24L.... We were cleared for takeoff on Runway 24L.... Just prior to lift-off speed, we observed [the] military transport start taxiing. He taxied onto runway 24L in front of us. We were then above the V1 speed, and our only option was to continue the takeoff. We were able to lift off over the military transport, but had our gross weight been closer to maximum, we might have had a real problem. [Upon] ... arrival at our destination, I called the ... [departure airport] Tower, and their people confirmed that the military transport had crossed Runway 24L without a clearance."

Three on-runway collisions during the recent times have sadly confirmed the risks associated with on-the-ground operations at major national airports. Pilot and ATC controller submissions to the ASRS frequently describe near-accidents involving active-runway incursions and transgressions. Analysis of such reports suggests that the routine and commonplace Ground or Tower Controller instruction -- hold short of Runway XX -- can potentially pose one of the most serious hazards in the entire ATC communications system.

- "On taxi-in ... I contacted Ground and reported clear of [Runway] 10. Ground said to hold short of [Runway] 22 at 'Charlie' ... I read back.... I completed the [after landing] checklist, called Ops and advised them we were on the ground (a required call) and then called Ramp Control to confirm our gate. I looked back up at the Captain ... and said, 'Gate is confirmed and we are still to hold short of 22!' He acknowledged me with a nod. I once again diverted my attention to the radio control panel ... when I looked up, Ground Control said 'air carrier (XX), hold short of 22.' At that time we were within 5 feet of Runway 22. The Captain slammed on the brakes. A small twin engine plane ... crossed directly in front of us on the takeoff roll. Had ... [he] been a larger aircraft with a greater wing span, there would have been contact!"

One hundred forty-one ASRS reports describing events that occurred between December 1987 through September 1990 were reviewed for this article. All errors were associated with three different phases of ground operations: taxi-out, taxi-in, and immediately after the landing roll-out. Most of these "hold-short clearance" reports entailed some degree of conflict (many of which were categorized as near-collisions). There were also go-arounds, and aborted or discontinued takeoffs.

Multiple Factors

Incidents reported to the ASRS are seldom the result of a single factor. Reviewing the details of runway incursion narratives reveals a complex matrix of interrelated causes. Pilot and controller mistakes may be combined factors in an incident, or perhaps distraction on the flight deck coupled with reduced visibility and inadequate airport signage could be cited. In an effort to reduce this intricate mass of information to digestible classifications, this article will examine causal factors under three main topic areas:

A. Airport Practices and Configurations,
B. Flight Crew Errors, and
C. Controller Errors.

A. Airport Practices and Configurations

As might be expected, the majority of events took place at major terminals with complex taxiway layouts and multi-runway operations. Incidents were grouped according to three differing classifications: *Intersecting Runways, Parallel Runways,* and *Runway Configuration No Factor.*

Configuration

Intersecting Runways

The Intersecting Runways classification specifies multiple, intersecting, active runways in use (simultaneous landing and departure operations on crossing runways). This category accounted for the largest number of ground conflicts.

Frequently and vigorously, pilots voiced serious concern about the practice of simultaneous operations on intersecting runways. In such instances, flight crews are commonly advised -- by ATIS or by controller restriction -- to hold short of the intersecting runway upon landing.

Flight crews either accepted the mandatory restriction, or were advised "if unable, expect a go around." "Intimidation," fumes one indignant reporter. Two pilots, unwilling to accept the limited landing distances, were circled around for second approaches.

Examination of the report set confirmed the flight crews' unease with "hold-short-of ..." instructions to landing aircraft. A number of aircraft committed an active-runway incursion during roll-out. The explanations were varied: operationally, pilots "floated," "tried to make a smooth landing," came in "slightly high," and/or "[were] ... concerned with a smooth deceleration."

Combining distraction and communication factors with intersecting runways, pilots "forgot" the hold short restriction, "did not hear" the transmission when issued during reversing, or became confused as to "where the crossing runway actually was." Another pilot "failed to consider" the reduced landing distance remaining available on the runway. Go-arounds, high speed aborts, and critical near collisions resulted from the intersecting runway transgressions.

- "We were cleared for takeoff on Runway 28 with landing traffic on [Runway] 33; the

landing traffic was a single engine light [aircraft] instructed 'cleared to land 33, hold short of Runway 28.' The [light aircraft] was going to land too long to hold short of 28, so he self-initiated a go-around as we were mid-field [on the] Runway 28 takeoff roll. The [pilot of the light aircraft] was instructed to make a left turn to avoid our flight path -- which he did ... landing clearances that stipulate hold short of intersecting Runway instructions are dangerous."

In another incident, one flight crew landing in poor visibility caused an abort as they continued through the intersection, then caused a second abort as they taxied onto a parallel runway.

Parallel Runways

Differing from the "Intersecting" category, the Parallel Runways classification includes those incidents where an aircraft exiting a runway after landing, inadvertently penetrates or crosses an active parallel runway. At many airports parallel runways may be very close together -- with minimum distance between. This category ranked second in the number of conflicts.
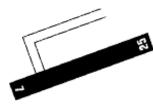
- "We were not mentally ready to stop so quickly after clearing the runway," explained one pilot. "The runways are so close," noted another reporter, "that you no sooner land and stop and you are right up to an active runway."

Another pilot, landing in reduced visibility conditions and then, still rolling with considerable velocity while exiting onto a high speed taxiway, nearly collided with an aircraft taking off on the adjacent parallel. He stated:

- "The problem is that you arrive at the conflict point immediately after landing due to the proximity of the ... [adjoining runway]."

The combined "Intersecting" and "Parallel" runway classifications accounted for over three-fourths of the incidents in this review.

Configuration No Factor

Finally, there are situations where Runway Configuration is not considered a factor in the incident. An aircraft that penetrates the active runway on the taxi-out from the gate is typical of this incident category. The lowest number of ground conflict incidents were found in this category.

Practices

Signs

It was clearly evident in the narratives that, whether familiar or unfamiliar with the airport layout, flight crews relied heavily on the airport signage system to guide their progress through the complexities of interconnected, criss-crossing taxiways and runways.

- " ... ground instructed us to taxi via [taxiway] Papa to Runway 32L, on 32 hold short of [taxiway] Golf. No problem ... as both the Captain and I have been based at the aerodrome for several years.... I asked the Captain if he knew where 'Golf' was. He replied that he had no idea of where it was, but would continue taxiing on Runway 32 until he saw a sign. I told him I'd have a look at the airfield diagram. He relied, 'Don't bother with that,' and continued taxiing. While I was heads-down digging out, and figuring out the airport diagram, we taxied past Golf, across 28C (an active runway), and stopped short of taxiway Charlie on Runway 32."

  This reporter sums up:

  "Factors: The Captain continued to taxi when unclear of [the] route. Complete lack of signs or other guidance on aerodrome. No sign at taxiway Golf or Charlie [was] visible from Runway 32 [while] taxiing southeast bound. First Officer should have had airport diagram page open and available, but did not due to familiarity and usual routine at [the] 'home 'drome.' "

And from other reporters:

- "I had been to XYZ [airport] only three times in the previous three weeks and was depending heavily on visual clues such as signs and taxi or hold lines."

- "No aircraft should be cleared to taxi on a runway ... unless hold short lines, prominent markings, and signs are displayed at intersecting runways, as are displayed on taxiways."

- "If taxi operations are going to be conducted on runways with crossing runways, then having yellow hold signs on the runway could help."

Other reporters suggested an alternative remedy. They ruefully concluded that instead of continuing to taxi while looking for signs, they

- " ... should have stopped and looked at the charts."

Endless Pavement

At some airports, pilots erred at least in part due to a lack of visual cues on wide expanses of paved surfaces. Ramp areas, inner/outer taxiways, and active runways merged into a single and puzzling "concourse of uncolored asphalt and concrete."

- "All the taxiways had grass islands between them. They were subsequently torn out and paved over, so all there is now is three-quarters [of a] mile of concrete ocean with low-contrast yellow pavementmarkings over light concrete."

B. Flight Crew Errors

In incidents where flight crew error was considered the primary contributor to the problem, several causal patterns were identified. These categories included communication problems, loss of positional awareness, distraction, and finally, situations in which the flight crew may not have sufficiently compensated for conditions of reduced visibility.

Communication

Controller/pilot miscommunication reports could be attributed to misunderstanding of what was intended or said by the controller; failure to read back critical instructions; and simply not hearing instructions directed to the cockpit. Clearance misinterpretations and neglected readbacks were typically pilot problems, while the "didn't hear" phenomenon could often be attributed to inopportune timing of ATC instructions, that is, during periods of high cockpit workload.

Misunderstanding

Flight crew misunderstandings of their hold short clearances developed from the garden path taxi instructions "to follow that ZZ aircraft in front of you to Runway YY, hold short of Runway XX." Three flight crews "were led to believe," or "understood," that when the aircraft they were following was cleared to cross Runway "XX," their flight needed no additional clearance to cross the active Runway "XX".

- " ... we were still following [aircraft] X as we were told to do. As [aircraft] X was crossing 8L, his jet blast was blowing snow, temporarily lowering visibility. After he crossed the runway and the visibility began to improve, we started to cross 8L [as well]. We were almost across when we heard the tower cancel air carrier B's takeoff clearance."

Readback

When flight crews misheard or misinterpreted their "hold short" instructions, the abbreviated response of "Roger, ABC," eliminated a crucial element in pilot/controller communication -- that of the controller's ability to confirm the flight crew's readback. In post-incident reflection, reporters regretted their short cut procedures:

- "I guess it was my fault for not giving a full readback ..."

- "Our mistake was in not reading back the Controller's instructions ..."

- "A complete readback on my part ... would have prevented this incident."

A Controller noted the second purpose of the double check step:

- "Perhaps a full readback would have helped me catch *my* mistake?" (Emphasis added.)

In an attempt to pass the buck, several reporters blamed the Ground Controller for not issuing instructions to acknowledge all hold short clearances.

Too Busy to Hear...

Reporters criticized the issuance of hold-short messages during periods of high workload, particularly when busily occupied with reversing, slowing, and braking on the runway. Pilot preparedness for potential hold short clearances could reduce the number of incidents in which unfortunately timed ATC instructions are a factor.

- " ... we were so ... [involved] with the landing and roll-out that we honestly did not hear

the requirement to hold short."

- " ... [a] twin turboprop ... rotated and climbed out over me.... ATC issued my taxi clearance and holding instructions while I was still rolling out from my landing, where workload is high...."

- "The [ATC] instructions to 'hold short of Runway 9L ...' came at a very bad time, and I missed it due to involvement in landing."

Positional Awareness

Many reports cited errors in the flight crews' perception of their position. Thirty-three pilot reporters attributed their inadvertent blunders onto active runways to their uncertainty about their precise location on the airport. Frequently used was the term "confusion:"

- "Captain became confused ... I was momentarily confused ... I repeated back the instructions to hold short of Runway XX before I knew exactly where I was ... I became confused as to where Runway XX actually was ... I found the intersections of Runways 36 and 23 and Taxiways Romeo and Lima confusing ... taxiways, runways and intersections -- extremely confusing."

Attention Management

The chronic problem of distraction emerged in twenty-three hold short incidents. At times, both pilots were "heads turned around" as "the Flight Attendant entered the cockpit with coffee ...," or "heads down" as both pilots focused upon FMS entries.

The source of breakdown in attention management (task management) on the flight deck are ranked as follows:

1. Checklists
2. Passenger announcements
3. Company radio calls
4. Miscellaneous (system malfunction, putting away manuals, etc.)
5. Flight attendant entering the cockpit
6. Conversation
7. FMS programming.

In taxi-out, reporters consistently referenced necessary but distracting tasks such as starting up an engine, running pre-takeoff checklists, and making the required passenger announcements. In taxi-in, reporters cited after-landing checklists and company radio calls. The distraction pattern was consistent: the pilot taxiing the aircraft did not adhere to the hold short instruction while the non-taxiing pilot was preoccupied with inside-the-cockpit tasks.

- "This incident could have been avoided if our company did not pressure the flight crews to spend so much time talking to the passengers when we should be operating the aircraft ..." complained one First Officer.

The breakdown in cockpit cross-check duties during taxi is recognized by flight crews. " ... A common problem ..." summarized a reporter, "is how the first officer is loaded up with work while we are taxiing out to a point that he/she can't always pay attention to the taxi procedure." (This applies to any pilot handling communications chores.)

The non-flying pilots' workload distractions were most critical when the aircraft neared the departure runway. With the First Officer running the pre-takeoff check lists, or being off tower frequency while making the passenger departure announcement, there was no double check on Captain misunderstandings of "hold short" and "hold," as a clearance for "position and hold." Go-arounds frequently resulted.

- "We were number two for departure on Runway 24R.... The first aircraft was cleared on the Runway for takeoff. At this time, the First Officer began to make the departure passenger announcement to the Flight Attendants. Simultaneously ... Tower, as I understood ... [incorrectly], said ' ... cleared into position and hold.' Since the First Officer was still making his passenger announcement, I acknowledged [the instruction].... An aircraft on final had to go around."

Visibility Problems

Restricted visibility -- blowing snow, fog, and rain -- served as contributory factors in three reports of flight crew disorientation. Such conditions call for extra caution on the part of pilots and controllers alike.

- "Due to the visibility restrictions, I didn't know where we were. I stopped. As I stopped ... a company jet passed us left to right with minimum clearance."

C. Controller Errors

The limited number of ATC controller reports in this classification did not permit a ranking of cause and circumstance for incidents perceived to be controller-induced events. Nonetheless, a review of reports in this study does indicate that incidents spanned a range of mental lapses, verbal slips, and visual misperceptions. Controllers neglected to tell aircraft to hold short, "thought one thing and said another," and became workload distracted with other aircraft movements. "The airplanes moved faster than my attention," was one Controller's explanation for a "near-tie" at a runway intersection. In four go-around events, Tower Controllers cleared air carriers into position and hold with an aircraft on short final.

The following causal factors were identified in reports of controller lapses:

1. Missed erroneous readbacks of hold short messages
2. Failed to issue hold short instructions
3. Mis-coordinated with Ground or Tower Controller positions
4. Distracted by other traffic
5. Distracted by conversation in the Tower
6. Miscellaneous: inadequate briefing of relief, developmental controller error, changed his mind, etc.

Hearback

Controller hearback misses of erroneous hold short readbacks were confirmed by "running the tapes." In six incidents, erroneous readbacks of hold short instructions were not caught by the controller. Two reports suggested heavy traffic volume as the underlying factor in controller errors.

- "I was preoccupied with trying to move some ... [aircraft around delayed aircraft] ... and didn't hear air carrier X read back that he was crossing ... with a departure rolling on [the] runway...."

Critical Timing

Timing of important communications was a factor in a number of incidents where flight crews did not hear hold short clearances during the roll-out after landing. (It is suggested that controllers attempt, as much as practical, to time their instructions for periods of lesser workload -- and provide lots of time.)

- "I did not hear the instructions because of being busy bringing the aircraft to a stop."

- "Immediately after landing, the Tower Controller issued us some lengthy instructions, which we neither could hear nor pay attention to until we came out of reversing and slowed [up]."

Look !

Frequently associated with the set of controller errors were pilot admittances of failing to visually check for other aircraft before crossing an active runway or moving into position. Controllers and pilots together need to maintain an eagle eye.

A Final Thought

Overall, whether in taxi-out, taxi-in, or in the after-landing roll-out phase, this review serves to identify the hazards in the common place instructions **"Hold Short of Runway XX."**

Note: Refer to the next article in this issue (*ASRS Directline* Issue # 3)--**"TAXI !"** -- for conclusions and recommendations for "on-the-ground operations."